

California Environmental Protection Agency

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**PERMEATION RATES OF SULFONATED  
TOTEM PLASTICS HIGH DENSITY POLYETHYLENE  
PORTABLE FUEL CONTAINERS**

Engineering and Certification Branch  
Monitoring and Laboratory Division

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# **PERMEATION RATES OF SULFONATED TOTEM PLASTICS HIGH DENSITY POLYETHYLENE PORTABLE FUEL CONTAINERS**

## **Introduction**

The California Air Resources Board (CARB) staff tested several Totem Plastics (Totem) High-Density Polyethylene (HDPE) portable fuel containers (containers) to determine average permeation rates. Totem submitted several 1 gallon, 2.5 gallon, 5 gallon and 1-gallon/80-ounce portable fuel containers to the CARB staff for evaluation. All the containers were barrier surface treated with sulfonation. Containers were preconditioned with commercial fuel, refilled with Phase II California Reformulated Certification (CERT) fuel, and subjected to a variable temperature profile. Permeation rates were then determined gravimetrically.

## **Test Protocol**

Totem submitted eight containers in June 2000. CARB staff filled all containers with commercial fuel in June to begin the preconditioning process. During the preconditioning process, in mid June, all containers were emptied and underwent the durability process per CARB Test Method 513. Although, this was a deviation from Method 513 it was necessary to perform the durability test. All containers were then refilled with commercial fuel and stored at ambient temperature and pressure in flammable storage cabinets. After four weeks of ambient preconditioning, the containers were emptied; blown dry with compressed zero air, and immediately refilled with CERT fuel. The containers were then sealed using a hand held fusion welder and 1/4" thick HDPE coupons and leak tested as specified in Test Method 513 (a copy can be found at the CARB web site: <http://www.arb.ca.gov/regact/spillcon/spillcon.htm>).

Weight loss was used to determine relative permeation rates. Sealed containers were weighed using a high capacity balance with a sensitivity of  $\pm 0.1$  grams. After each container was weighed and the weight recorded, they were placed in the Sealed Housing for Evaporative Determination (SHED) and exposed to a 1-day/24-hour/1440-minute variable temperature profile (see Attachment 1). This process is considered our diurnal cycle (recurring every day). Containers were then post weighed after each 24-hour diurnal cycle and the weight loss calculated.

## **Results**

Cumulative weight losses were determined for each container as a function of time. The containers underwent a total of thirteen diurnal cycles, but results are calculated using only ten cycles, each cycle is 24-hours. The first three days of test data were not used in determining individual per container permeation rates

due to high variability. A summary of all test results can be found in Attachment 2.

The average permeation rate from the 5-gallon containers designated TP1S and TP2S was determined to be 0.08 grams/gallon/day. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles.

The average permeation rate from the 2.5-gallon containers designated TP3S and TP4S was determined to be 0.05 grams/gallon/day. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles.

The average permeation rate from the 1-gallon containers designated TP5S and TP6S was determined to be 0.05 grams/gallon/day. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles.

The average permeation rate from the 1-gallon/80-ounce containers designated TP7S and TP8S was determined to be 0.10 grams/gallon/day. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles.

## Attachment 1

1 Day / 24 Hour / 1440 Minute Variable Temperature Profile

HOUR	MINUTE	ELAPSE TIME (MINUTES)	TEMPERATURE (°F)
0	0	1440	65.0
1	60	1380	66.6
2	120	1320	72.6
3	180	1260	80.3
4	240	1200	86.1
5	300	1140	90.6
6	360	1080	94.6
7	420	1020	98.1
8	480	960	101.2
9	540	900	103.4
10	600	840	104.9
11	660	780	105.0
12	720	720	104.2
13	780	660	101.1
14	840	600	95.3
15	900	540	88.8
16	960	480	84.4
17	1020	420	80.8
18	1080	360	77.8
19	1140	300	75.3
20	1200	240	72.0
21	1260	180	70.0
22	1320	120	68.2
23	1380	60	66.5
24	1440	0	65.0

## Attachment 2

### PERMEATION TEST RESULTS

July and September 2000

Diurnal Cycles* (# 24 hr cycles)	Container Identification	Container Mfg.	Container Volume	Test Dates	Fuel Type	Avg. Loss (g/gal/day)
10	TP1S	Totem Plastics	5 gallon	9/8 - 9/22	CERT	0.11
10	TP2S	Totem Plastics	5 gallon	9/8 - 9/22	CERT	0.05
<b>Average</b>						<b>0.08</b>
10	TP3S	Totem Plastics	2.5 gallon	7/14 - 7/28	CERT	0.08
10	TP4S	Totem Plastics	2.5 gallon	7/14 - 7/28	CERT	0.03
<b>Average</b>						<b>0.06</b>
10	TP5S	Totem Plastics	1 gallon	7/14 - 7/28	CERT	0.06
10	TP6S	Totem Plastics	1 gallon	7/14 - 7/28	CERT	0.05
<b>Average</b>						<b>0.05</b>
10	TP7S	Totem Plastics	1-gal/80-oz	7/14 - 7/28	CERT	0.14
10	TP8S	Totem Plastics	1-gal/80-oz	7/14 - 7/28	CERT	0.12
<b>Average</b>						<b>0.13</b>

\*The results are based on 10 diurnal cycles, although 13 were performed. The first 3 days were not included because of high variability.